AMENDMENTS TO THE CLAIMS

Listing of Claims

1. (**Currently Amended**) A method for estimating the phase in a digital communication system comprising the steps of:

[[-]] receiving and storing a block of observations Y_k; and

[[-]] executing ~~at least~~ more than one phase locked loop (PLL) on a predetermined sequence of observations from said block.

2. (**Currently Amended**) The method for estimating the phase in a digital communication system according to claim 1 characterized by:

[[-]] executing a first ~~phase locked loop (PLL)~~ PLL on said observations according to their chronological order of occurrence in order to generate a first intermediate value;

[[-]] executing a second ~~phase locked loop (PLL)~~ PLL on said observations according to their inverse chronological order of occurrence in order to generate a second intermediate value; and

[[-]] combining said first and second intermediate values to generate a phase estimate.

3. (**Currently Amended**) [[The]] A method ~~according to claim 2~~ for estimating the phase in a digital communication system, comprising the steps of:

receiving and storing a block of observations Y_k;

executing at least one phase locked loop (PLL) on a predetermined sequence of observations from said block;

executing a first PLL on said observations in order to generate a first intermediate value;

executing a second PLL on said observations in order to generate a second intermediate value; and

combining said first and second intermediate values to generate a phase estimate,

characterized in that said first ~~loop~~ PLL executes on a sequence of observations according to their chronological order of occurrence, and that said second loop executes on the inverse sequence.

4. (**Currently Amended**) The method according to claim 3 characterized in that said second ~~phase locked loop (PLL)~~ PLL is initialized to the last value calculated by said first ~~phase locked loop~~ PLL.

5. (**Currently Amended**) [[The]] A method ~~according to claim 4 characterized in that it comprises~~ for estimating the phase in a digital communication system, comprising the steps of:

[[-]] receiving and storing a block of observations Y_k of an output signal from a complex demodulator, with k varying from 0 to n;

[[-]] initializing [[a]] said first ~~phase locked loop~~ PLL from received observations Y_k;

[[-]] executing said first ~~phase locked loop~~ PLL according to the following formula: $\varphi_k = \varphi_{k-1} - \gamma F(Y_k, \varphi_{k-1})$ with k = 1 to n, where F is a function adapted to the type of modulation considered, where φ is a phase of an observation of the output signal from the complex demodulator, and where γ is realized by means of a second-order digital filter according to the formula $\gamma = \gamma_1 + \gamma_2/(1 + z^{-1})$;

[[-]] initializing [[a]] said second ~~phase locked loop~~ PLL from observations Y_k, with k varying from n to 0;

[[-]] executing said second ~~phase locked loop (PLL)~~ PLL according to the following formula: $\varphi'_k = \varphi'_{k+1} - \gamma F(Y_k, \varphi'_{k+1})$ with k = n-1 to 0; and

[[-]] combining the results produced by said first and second loops to generate a phase estimate.

6. (**Currently Amended**) A method according to ~~any of the preceding claims~~ claim 5, characterized in that the modulation is a binary phase shift keying (BPSK) modulation with a phase locked loop (PLL) defined by

~~$\varphi_K = \varphi_{k-1} + \gamma\,\mathrm{Img}\,(y_k\, e^{-i\varphi(k-1)}\, \mathrm{th}[\, L_k / 2 + 2 / \sigma^2\, \mathrm{Re}(y_k\, e^{-I\varphi(k-1)}]\,)$~~

$\varphi_k = \varphi_{k-1} + \gamma \mathrm{Img}(y_k e^{-i\varphi(k-1)})\ \mathrm{th}[L_k/2 + 2/\sigma^2 \mathrm{Re}(y_k e^{-I\varphi(k-1)})]$, where:

th is the hyperbolic tangent operator,

Re is the operator referring to the real part of a complex number,

σ^2 is the noise variance[[;]],

[[and]] $L_k = \mathrm{Ln}[p(a_k = 1) / p(a_k = -1)]$,

[[and]] Ln is the natural logarithm,

~~p(ak = 1)~~ $p(a_k = 1)$ is the probability that symbol a_k is equal to +1, and

$p(a_k = -1)$ is the probability that symbol a_k is equal to -1.

7. (**Original**) The method according to claim 6 characterized in that said factor γ is realized by means of a second or higher order digital filter.

8. (**Canceled**)

9. (**Currently Amended**) [[The]] A phase locked loop device ~~according to claim 8~~ for a digital receiver for receiving a signal having a type of modulation, comprising:

means to receive and store blocks of observations;

a first phase locked loop (PLL) for generating a first intermediate value;

a second phase locked loop (PLL) for generating a second intermediate value; and

means to derive a phase estimate from said first and second intermediate values,

characterized in that said first and second phase locked loops are realized according to the following formula:

$$\varphi_k = \varphi_{k-1} - \gamma F(Y_k, \varphi_{k-1}) \text{ with } k = 1 \text{ to } n$$

or

$$\varphi'_k = \varphi'_{k+1} - \gamma F(Y_k, \varphi'_{k+1}) \text{ with } k = n-1 \text{ to } 0,$$

where F is a function adapted to the type of modulation ~~considered~~ received,
Y is an observation of an output signal from a complex demodulator,
φ is a phase of an observation of the output signal from the complex demodulator, and
γ is realized by means of a second-order digital filter according to the formula
$\gamma = \gamma_1 + \gamma_2/(1 + z^{-1})$.

10. (Original) The device according to claim 9 characterized in that the first value calculated by said second loop is determined by the last calculation made by said first phase locked loop.